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Wilcox

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(54) **RIVET FEEDING APPARATUS**

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B23K 11/00 (2006.01)
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(52) **U.S. Cl.**
CPC ***B21J 15/32*** (2013.01); ***B23K 11/0053*** (2013.01); ***B23K 11/115*** (2013.01); ***B23K 11/36*** (2013.01);
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(58) **Field of Classification Search**
CPC B21J 15/32; B21J 15/323; B25C 1/001; B23K 11/36; B23K 11/115;
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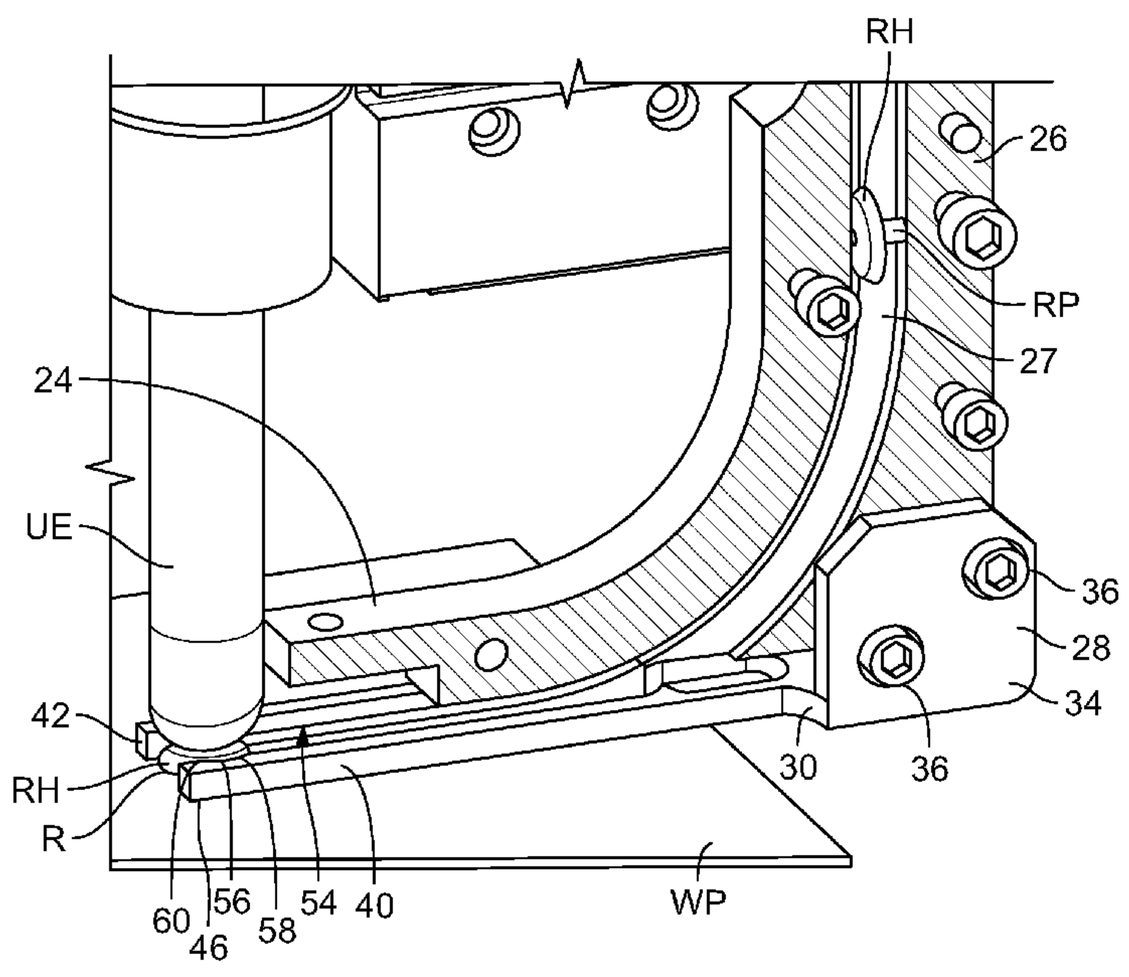
(57) **ABSTRACT**

A fastener feed apparatus includes a mounting portion and a feed portion attached movably thereto. The feed portion includes a feed body having first and second ends and an internal track extending therethrough. The internal track is sized and shaped to convey a fastener through the feed body. The feed portion also includes a feeding block attached to the second end of the feed body and including a body and a pair of feed fingers, each of which includes a first end attached to the body and a second end. A track is formed between the feed fingers, is sized and shaped to convey the fastener from its first end to its second end, and is contiguous with the internal track of the feed body. The second end of the track includes a retention point. The feed fingers are sized and shaped to retain the fastener at the retention point.

34 Claims, 4 Drawing Sheets



(51) **Int. Cl.**

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B23K 11/11	(2006.01)
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USPC 173/1–2, 13, 31, 38–39, 45–56, 90, 130, 173/133, 121, 162, 170–171; 227/107–156
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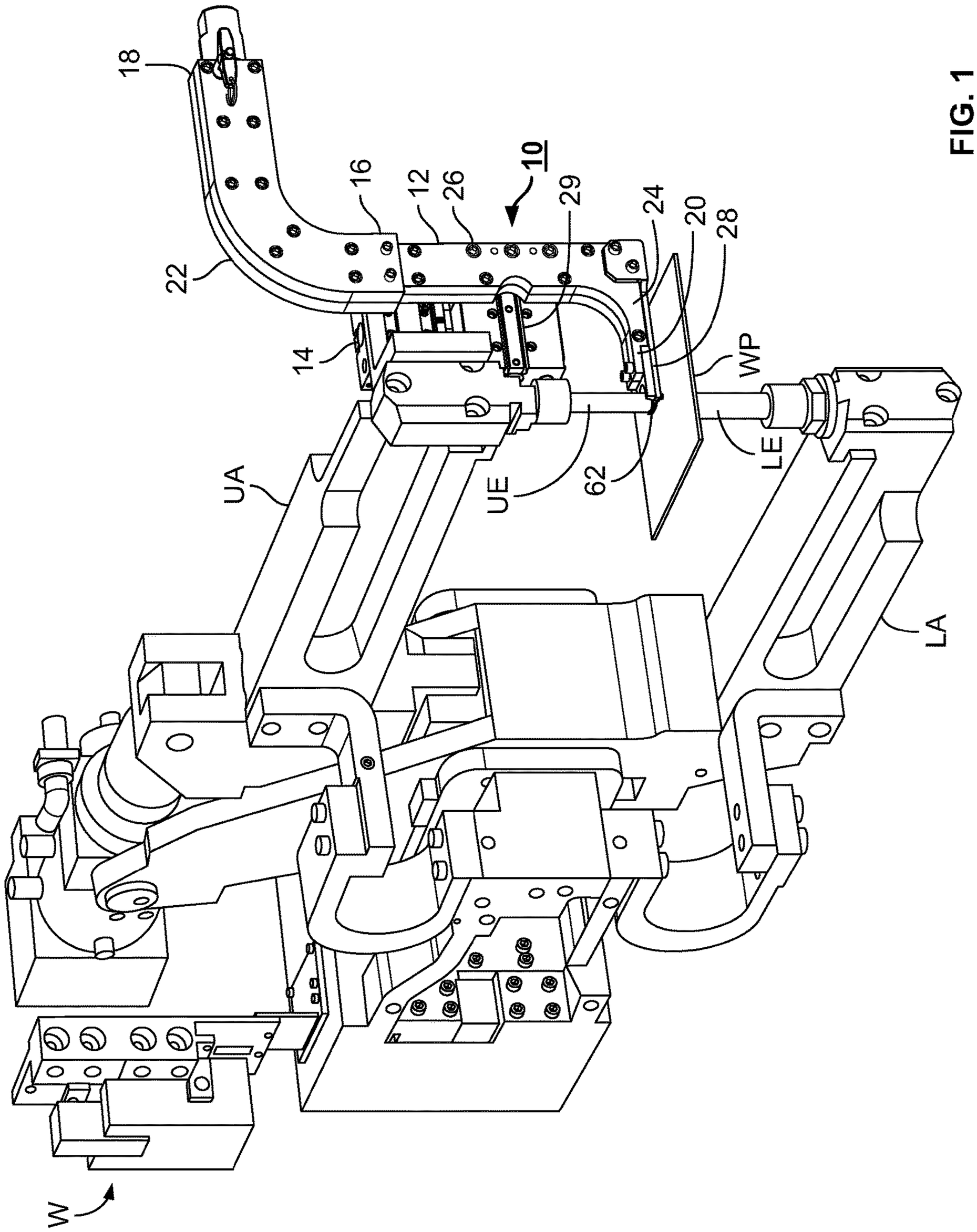


FIG. 1

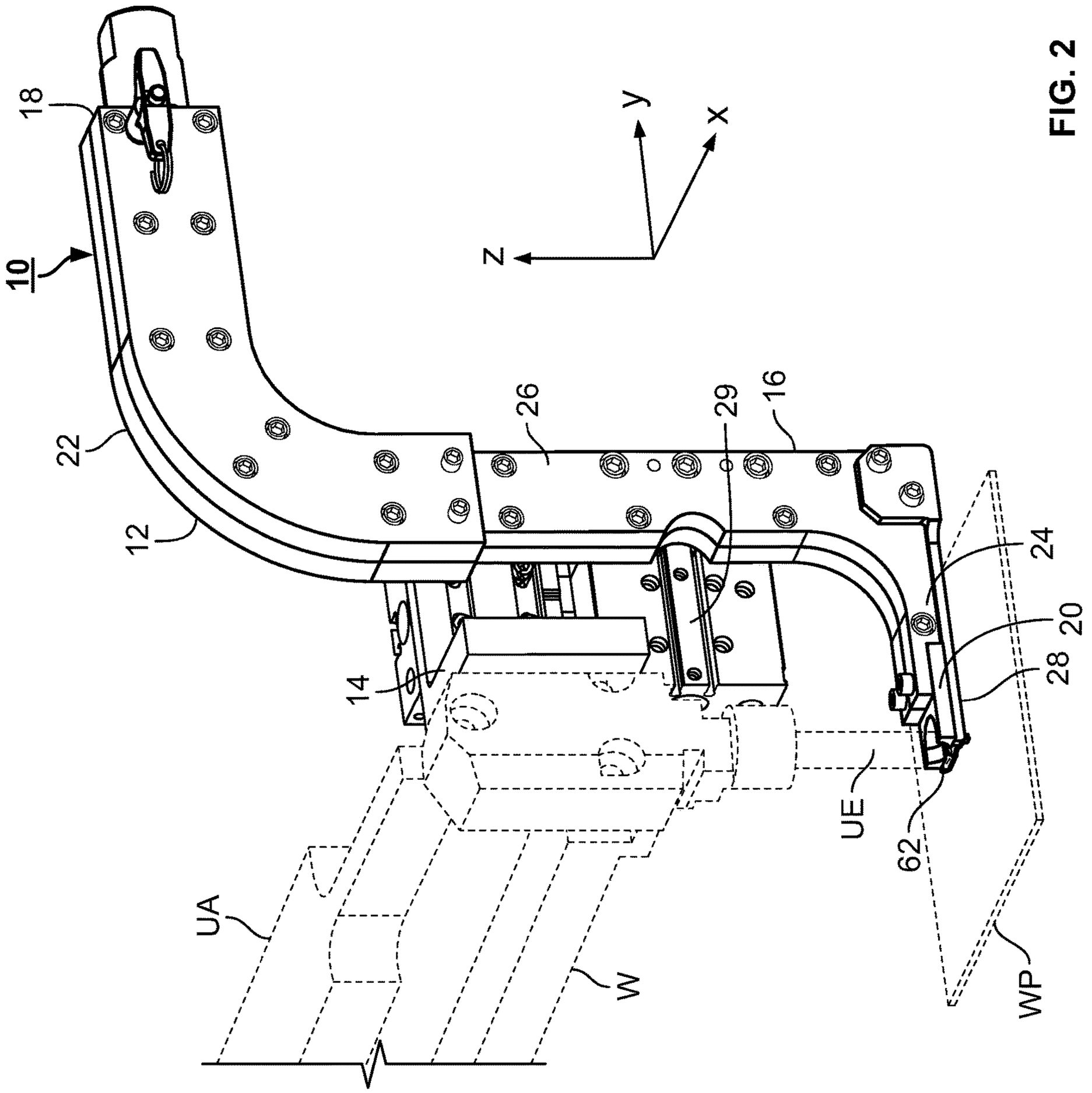


FIG. 2

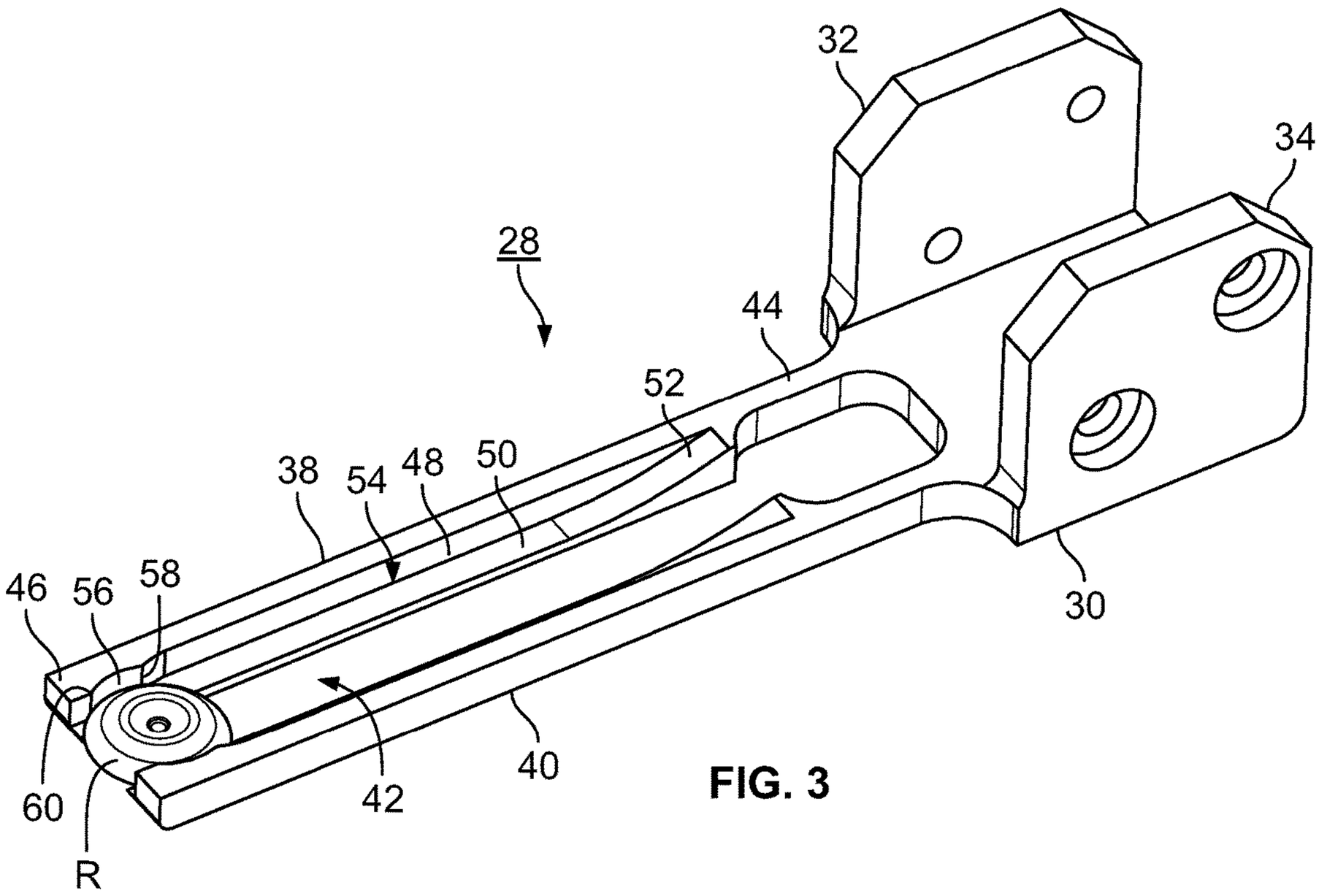


FIG. 3

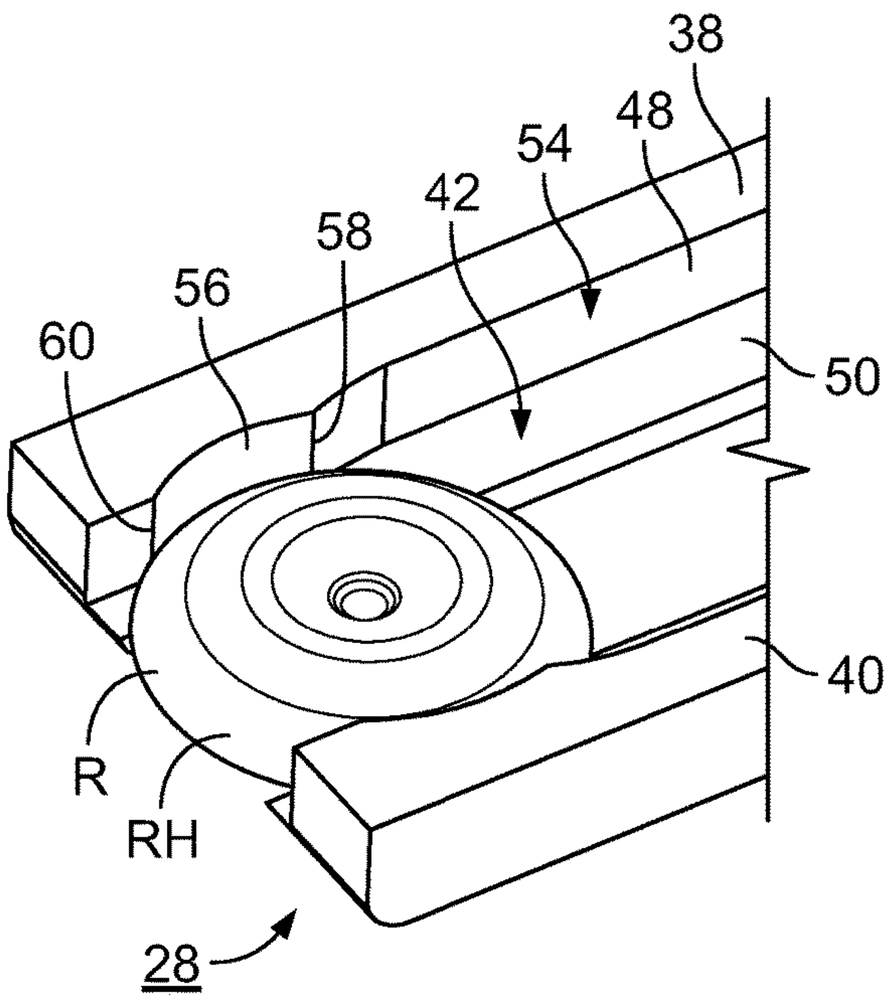


FIG. 4

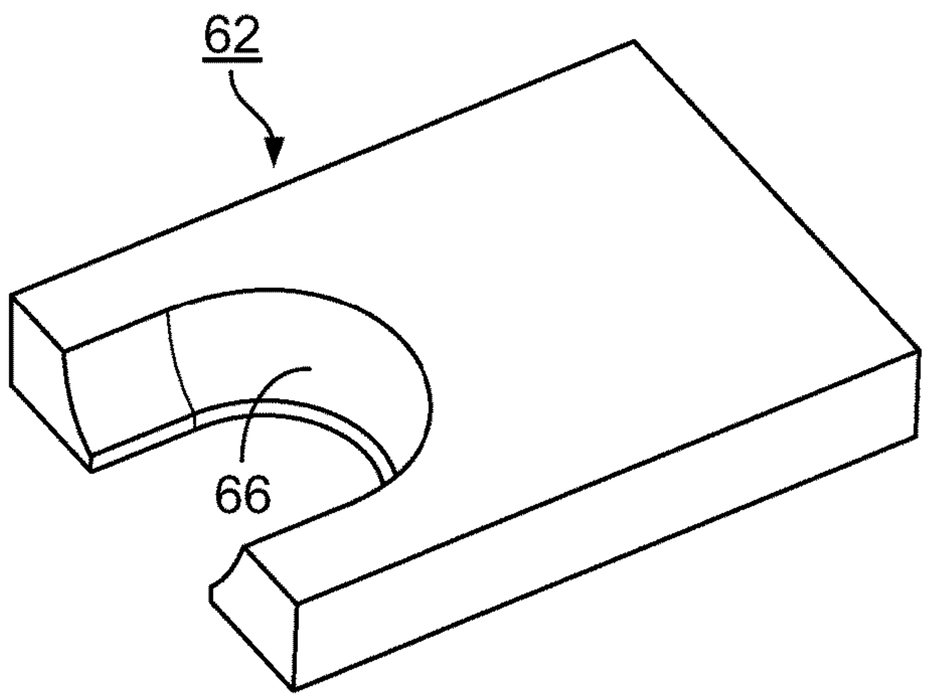
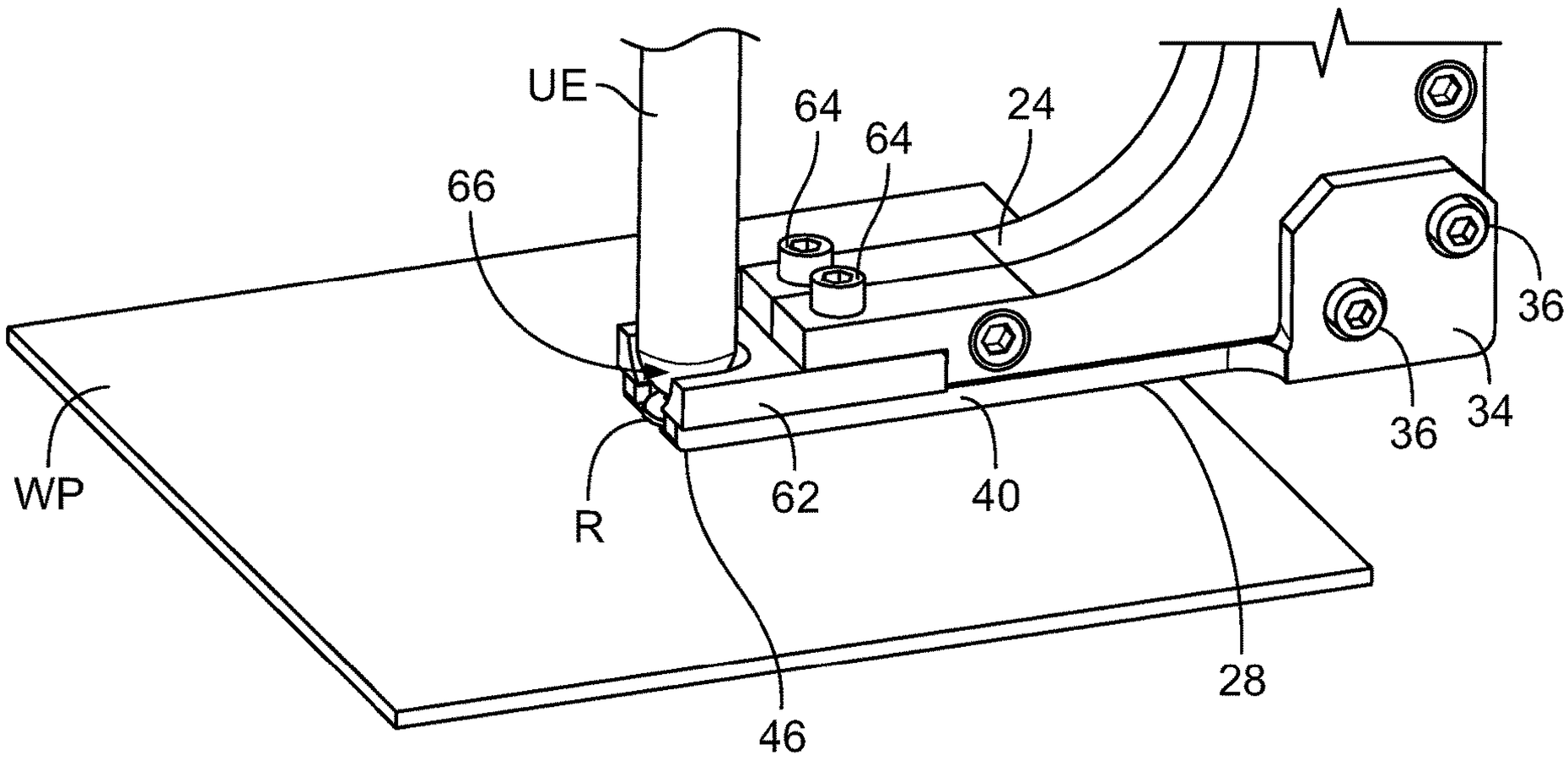


FIG. 5


UE
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WP
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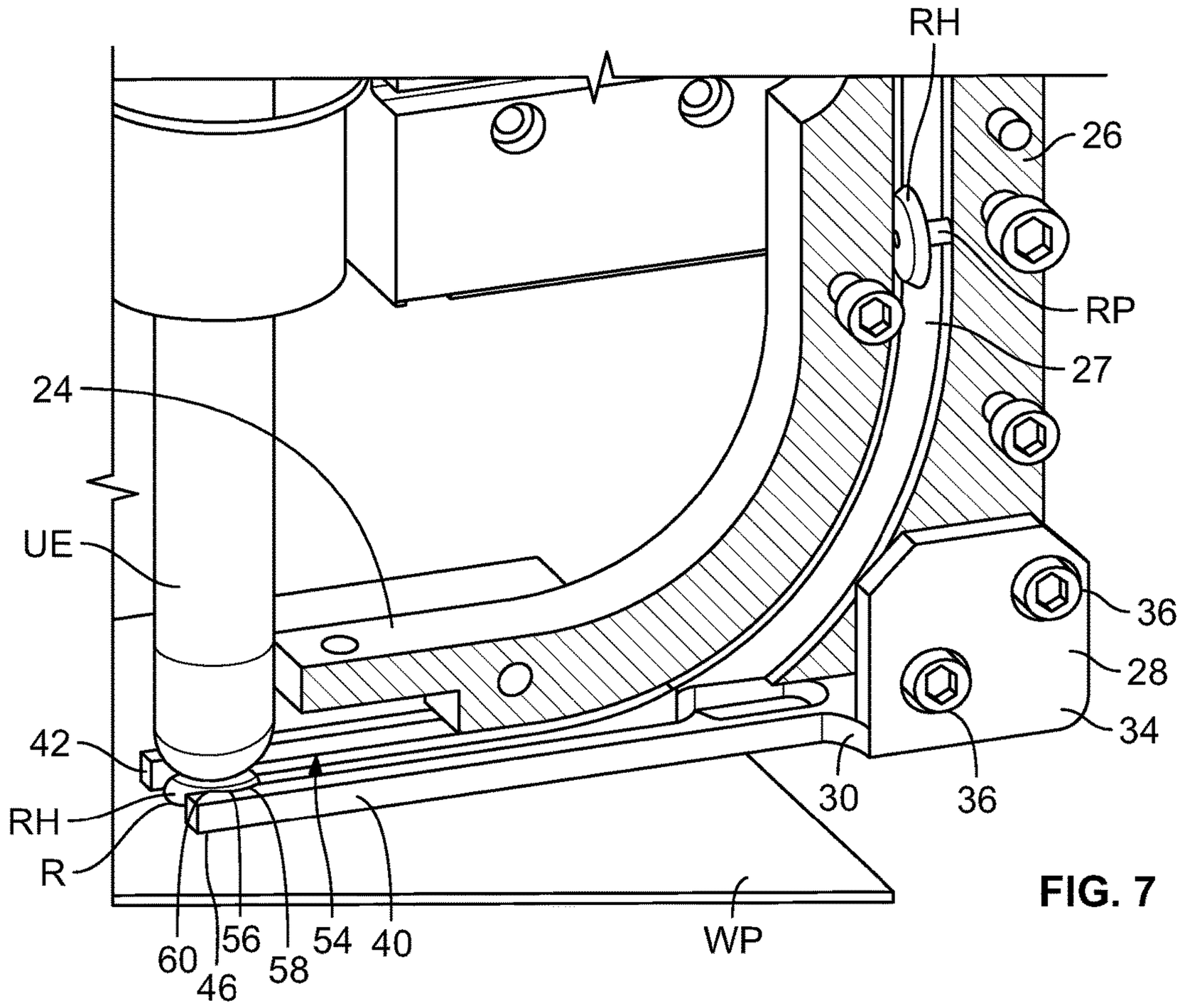
FIG. 6


RH
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RP
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UE
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RH
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40
WP

FIG. 7

RIVET FEEDING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application is a Section 111(*a*) application relating to and claiming the benefit of commonly owned, U.S. Provisional Patent Application No. 62/219,206, titled "RIVET FEEDING APPARATUS," having a filing date of Sep. 16, 2015, which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

The present invention relates to a rivet feeding apparatus and, more particularly, a feeder for resistance spot weld rivets.

BACKGROUND OF THE INVENTION

Current methods of fastening workpieces such as sheets to one another include conventional spot welding, the use of self-piercing rivets, and the use of flow drill rivets. The latter two methods require feeding systems for the rivets. What is needed is a compact rivet feeding apparatus that fits within a limited space and does not employ complicated actuators and mechanisms, as well as an apparatus that provides robust means to hold a rivet in place that is not sensitive to environmental factors, such as dirt, carbon build-up, clogging, dust, and sparks.

SUMMARY OF THE INVENTION

In an embodiment, a fastener feed apparatus includes a mounting portion and a feed portion attached movably to the mounting portion. The feed portion includes a feed body and a feeding block. The feed body has a first end, a second end opposite the first end, and an internal track extending through the feed body from the first end to the second end. The internal track is sized and shaped to enable conveyance of a fastener therethrough from the first end to the second end. The feeding block includes a body and a pair of feed fingers, each of which includes a first end attached to the body and a free, second end opposite the first end of the feed finger. A track is formed between the feed fingers. The track includes a first end adjacent the first ends of the feed fingers and a second end adjacent the second ends of the feed fingers. The track is sized and shaped to convey the fastener from the first end of the track to the second end of the track. The track is contiguous with the internal track of the feed body. The second end of the track includes a retention point. The feed fingers are sized and shaped to enable retention of the fastener at the retention point.

In an embodiment, each of the feed fingers of the feeding block includes an inner guiding diameter portion located proximate to the second end thereof. The inner guiding diameter portions define a first distance therebetween. In an embodiment, the retention point of the track of the feeding block includes the inner guiding diameter portions. In an embodiment, each of the feed fingers of the feeding block includes an inner wall located proximate to the first end thereof. The inner walls of the feed fingers face one another and define a second distance therebetween. The second distance is greater than the first distance. In an embodiment, each of the feed fingers of the feeding block includes a stop point located proximate to the inner guiding diameter portions of the feed fingers and intermediate the inner guiding diameter portions and the second ends of the feed fingers. The stop points define a third distance therebetween. In an embodiment, the third distance is less than the first distance. In an embodiment, the feed fingers are sized and shaped to prevent them from flexing away from one another to an extent such that the fastener is free to pass between the stop points of the feed fingers when the fastener impacts the stop points after traveling along the internal track of the feed body from the first end of the feed body to the second end of the feed body and along the track of the feeding block from the first end of the feeding block to the second end of the feeding block. In an embodiment, the feed fingers are sized and shaped so as to enable them to flex away from one another to an extent such that the fastener is permitted to pass between the stop points of the feed fingers when the feed portion is operated to move away from a workpiece along first and second axes thereof.

In an embodiment, each of the feed fingers of the feeding block includes an anti-return point located proximate to the inner guiding diameter portions and intermediate the inner guiding diameter portions and the first ends of the feed fingers. The anti-return points of the feed fingers define a fourth distance therebetween. In an embodiment, the fourth distance is less than the first distance. In an embodiment, the feed fingers are sized and shaped so as to allow them to flex away from one another to an extent such that the fastener is permitted to pass between the anti-return points of the feed fingers.

In an embodiment, the feed portion includes a finger cover overlaying the second ends of the feed fingers. In an embodiment, the finger cover includes a bowl-shaped cavity overlaying the retention point of the feeding block. In an embodiment, the cavity is sized and shaped to receive a first fastening arm of a fastening apparatus. In an embodiment, the fastener feed apparatus also includes a linear actuator configured to move the feed portion relative to the mounting portion. In an embodiment, the fastener includes a rivet. In an embodiment, the fastener includes a plurality of rivets stacked among one another.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a rivet feed system attached to a welding apparatus;

FIG. **2** illustrates a close-up view of the rivet feed system of FIG. **1**;

FIG. **3** illustrates a top perspective view of a feeding block employed by the rivet feed system shown in FIG. **2**;

FIG. **4** illustrates a close-up view of one end of the feeding block shown in FIG. **3**;

FIG. **5** illustrates a top perspective view of a finger cover employed by the rivet feed system shown in FIG. **2**;

FIG. **6** illustrates a close-up view of portions of the rivet feed system and welding apparatus shown in FIG. **1**; and

FIG. **7** illustrates a sectional view of a portion of the rivet feed system shown in FIG. **5**.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an embodiment of a rivet feed system **10** attached to a welding apparatus W, positioned with respect to a workpiece WP. FIG. **2** illustrates the rivet feed system **10**, the workpiece WP, and a portion of the welding apparatus W of FIG. **1**, with the rivet feed system **10** shown in solid lines and the workpiece WP and welding apparatus W shown in dashed lines. In an embodiment, the welding apparatus W is a pinch welder utilized in connection with

resistance spot weld rivets (RSRs). In an embodiment, the welding apparatus W includes upper and lower resistance welding arms UA, LA that are spaced apart and opposed to one another. The resistance welding arm UA includes a corresponding upper welding electrode UE, while the resistance welding arm LA includes a corresponding lower welding electrode LE. When the welding apparatus W is in use, the upper welding electrode UE and the lower welding electrode LE are positioned on opposite sides of a workpiece WP.

Referring to FIGS. **1** and **2**, the rivet feed system **10** includes a feed portion **12** and a mounting portion **14** (e.g., a mounting block). In an embodiment, the rivet feed system **10** is mounted to the welding apparatus W by attaching the mounting portion **14** to the upper resistance welding arm UA. In an embodiment, the feed portion **12** is generally "S"-shaped and includes a feed body **16** having a first (i.e., upper) end **18**, a second (i.e., lower) end **20**, a top curved portion **22** located at the first end **18**, a horizontal bottom portion **24** located at the second end **20**, and an intermediate vertical linear portion **26** extending from the top curved portion **22** to the horizontal bottom portion **24**. In an embodiment, a feed track **27** (shown in FIG. **7**) is located in the interior of the feed body **16** and extends from the first end **18** to the second end **20**. In an embodiment, the feed track **27** is sized and shaped so as to allow the passage of a rivet R therethrough and to maintain the rivet R in a desired orientation during such passage. In one or more embodiments, the feed body **16** includes a pivoting mechanism or a linkage **29** that enables motion of the feed body **16** along the Y-axis in FIG. **2** (i.e., across the surface of a workpiece WP).

Referring now to FIGS. **1** through **4**, in an embodiment, the rivet feed system **10** includes a feeding block **28** attached to the bottom portion **24** of the feed body **16**. Referring to FIGS. **3** and **4**, in an embodiment, the feeding block **28** includes a base **30** having a pair of mounting brackets **32**, **34** extending outwardly for mounting the feeding block **28** to the bottom portion **24** of the feed portion **12** by fasteners **36** (which are shown in FIGS. **6** and **7**). A pair of feed fingers **38**, **40** extends longitudinally from the base **30** and are opposed and spaced apart from one another, forming a space **42** therebetween. In an embodiment, and as will be further discussed in detail below, the feed fingers **38**, **40** are adapted to flex laterally and apart from one another (i.e., away from the space **42**). Each of the feed fingers **38**, **40** includes a first end **44** formed integrally with the base **30** and a free, second end **46** opposite the first end **44**. Each of the feed fingers **38**, **40** includes an inner wall **48** and a lower wall **50**. The lower wall **50** of each of the feed fingers **38**, **40** includes a ramped portion **52** located proximate to the first end **44**. The inner wall **48** and the lower wall **50** of each of the feed fingers **38**, **40** cooperate to form a track **54** extending from the ramped portion **52** to the second end **46**. In an embodiment, when the feeding block **28** is mounted to the feed body **16**, the track **54** is adjacent to and contiguous with the feed track **27** of the feed body **16**.

Proximate to the second end **46**, the inner wall **48** of each of the feed fingers **38**, **40** includes an inner guiding diameter portion **56**, which forms an anti-return point **58** at one end thereof and a stop point **60** at the other end thereof. In an embodiment, the anti-return points **58** and the stop points **60** cooperate to act as a retention means for rivets R, and are positioned such that one of the rivets R may be held in position therebetween. In other embodiments, the feed body **16** includes a retention detent or a leaf spring that provides an anti-return feature, either rather than or in addition to the anti-return points **58**. In an embodiment, the width between the inner guiding diameter portions **56** is narrower than the width of between the inner walls **48** of the feed fingers **38**, **40**. As to be discussed in greater detail below, the fingers **38**, **40** are adapted to receive and maintain in position one of the rivets R for welding to a workpiece WP. The inner guiding diameter portion **56**, the anti-return point **58**, and the stop point **60** thereby cooperate to define a retention point at which one of the rivets R may be retained prior to fastening.

Referring now to FIGS. **5** and **6**, in an embodiment, the rivet feed system **10** includes a finger cover **62**, which is mounted to the second end **20** of the feed body **16** by fasteners **64**. The finger cover **62** is positioned on top of the feed fingers **38**, **40** of the feeding block **28** at the second ends **46** thereof. In an embodiment, the finger cover **62** includes a bowl-shaped cavity **66** that is aligned with the guiding diameter portions **56** of the feed fingers **38**, **40**, and is sized and shaped to receive a tip of the upper welding electrode UE.

Referring now to FIGS. **5** through **7**, in an embodiment, a rivet R includes a disc-shaped head RH and a central pin RP (shown in FIG. **7**) extending therefrom. When the rivet feed system **10** is in operation, rivets R are fed into the portion of the feed track **27** located at the first end **18** of the feed body **16** with air pressure applied by a further device (not shown). In an embodiment, the rivets R are fed one at a time. In other embodiments, the rivets R may be fed in a stack. In an embodiment, each rivet R travels along the feed track **27** as it passes through each of the portions **24**, **26**, **28** of the feed body **16**, with the head RH of the rivet R sliding along the feed track **27** and the pin RP being positioned in the associated space within the track. When the rivet R reaches the bottom portion **24** of the feed body **16** (i.e., the end of the feed track **27**), it leaves the feed track **27**, travels along the track **54** formed by the feed fingers **38**, **40**, and stops at the ends **46** of the feed fingers **38**, **40**. As shown in FIGS. **2** and **6**, motion along the Y-axis and Z-axis is used to move the feeding block **28** down and over so that the rivet R is positioned under the tip of the upper welding electrode UE. Motion along the Y-axis and Z-axis may be provided by any type of linear actuator. In an embodiment, the linear actuator is a pneumatic actuator.

In an embodiment, the feed fingers **38**, **40** employ a momentum-based retention system. In this regard, the rivet R travels through the feed body **18** and along the feed track **27** at a relatively high velocity (i.e., as induced by air pressure that feeds the rivet R into the feed track **27**, as described above). The velocity of the rivet R is such that when the rivet R engages the track **54** of the feeding block **28**, the momentum of the rivet R causes the feed fingers **38**, **40** to flex open laterally and outwardly (i.e., away from the space **42**) as the rivet R passes the anti-return points **58** on the feed fingers **38**, **40**. However, the momentum of the rivet R is not high enough for the feed fingers **38**, **40** to flex apart from one another to such an extent that the rivet R is able to travel completely past the second ends **46** of the feed fingers **38**, **40**. This is the case because the width between the inner guiding diameter portions **56** of the feed fingers **38**, **40** is narrower than the width between the inner walls **48**. As a result, more force than is provided due to the momentum of the rivet R would be required to flex the feed fingers **38**, **40** apart from one another to a great enough extent to allow the rivet R to travel past the second ends **46** of the feed fingers **38**, **40**. Consequently, the rivet R is stopped by the stop points **60** of the feed fingers **38**, **40** and is prevented from traveling completely past the second ends **46** of the feed fingers **38**, **40**. When the rivet R has reached the stop points

60, it is nestled within the guiding diameter portions **56** of the feed fingers **38**, **40**, and is in position and ready to be fed under the upper welding electrode UE by the Y-axis and Z-axis motions of the feeding block **28**.

The electrode UE of the welding arm UA is positioned to pin the rivet R to the workpiece WP. In an embodiment, the workpiece WP can be steel, aluminum or carbon fiber. Once the rivet R is pinned to the workpiece WP by the electrode UE, the feed portion **12** is retracted in the directions of the Y-axis and Z-axis to leave the rivet R behind. Current is applied by the electrodes UE, LE to weld the rivet R to the workpiece WP. Afterwards, the feed portion **12** is moved to the next location to be riveted, next rivet R is fed into the feed portion **12** with pressurized air, and the cycle repeats.

The rivet feed system **10** may accommodate rivets R having various depths of the rivet pin RP without the need to change the feed portion **12**. In an embodiment, the rivet feed system **10** is used for resistance spot weld rivets. In other embodiments, the rivet feed system **10** can be utilized for other types of rivets or fasteners.

It should be understood that the embodiments described herein are merely exemplary and that a person skilled in the art may make many variations and modifications without departing from the spirit and scope of the invention. All such variations and modifications are intended to be included within the scope of the invention as exemplified by the appended claims.

The invention claimed is:

1. A fastener feed apparatus, comprising:

a mounting portion; and

a feed portion attached to the mounting portion, the feed portion including

a feed body having a first end, a second end spaced from the first end, and a track extending from the first end to the second end, the track being sized and shaped to enable conveyance of a fastener from the first end to the second end, and

a feed block attached to the second end of the feed body and including a body and a pair of feed fingers extending from the body, each of which includes a first end formed integrally with the body and a second end opposite the first end of the feed finger such that the feed fingers are moveable between a relaxed position, in which the feed fingers are juxtaposed with one another, and a biased position, in which the feed fingers are resiliently biased away from one another at the second ends of the feed fingers, a track formed between the feed fingers, the track of the feed block including a first end adjacent the first ends of the feed fingers and a second end adjacent the second ends of the feed fingers, the track of the feed block being sized and shaped to convey the fastener from the first end of the track of the feed block to the second end of the track of the feed block, the track of the feed block being aligned with the track of the feed body, the second end of the track of the feed block including a retention area, and the feed fingers being sized and shaped to enable retention of the fastener at the retention area,

wherein the feed fingers, when in their biased positions, provide a lateral force against the fastener to enable retention of the fastener at the retention area and prevent the fastener from traveling past the second ends of the feed fingers.

2. The fastener feed apparatus of claim **1**, wherein each of the feed fingers of the feed block includes a guiding portion located proximate to the second end thereof, and wherein the guiding portions define a first distance therebetween.

3. The fastener feed apparatus of claim **2**, wherein the retention area of the track of the feed block includes the guiding portions.

4. The fastener feed apparatus of claim **3**, wherein each of the feed fingers of the feed block includes a wall located proximate to the first end thereof, wherein the walls of the feed fingers face one another, wherein the walls of the feed fingers define a second distance therebetween, and wherein the second distance is greater than the first distance.

5. The fastener feed apparatus of claim **4**, wherein each of the feed fingers of the feed block includes a stop located proximate to the guiding portions of the feed fingers and intermediate the guiding portions and the second ends of the feed fingers, and wherein the stops define a third distance therebetween.

6. The fastener feed apparatus of claim **5**, wherein the third distance is less than the first distance.

7. The fastener feed apparatus of claim **5**, wherein the feed fingers are sized and shaped to prevent them from biasing away from one another to an extent such that the fastener is free to pass between the stops of the feed fingers when the fastener impacts the stops after traveling along the track of the feed body from the first end of the feed body to the second end of the feed body and along the track of the feed block from the first end of the feed block to the second end of the feed block.

8. The fastener feed apparatus of claim **7**, wherein the feed fingers are sized and shaped so as to enable them to resiliently bias away from one another to an extent such that the fastener is permitted to pass between the stops of the feed fingers when the feed portion is operated to move away from a workpiece along first and second axes thereof.

9. The fastener feed apparatus of claim **3**, wherein each of the feed fingers of the feed block includes an anti-return area located proximate to the guiding portions and intermediate the guiding portions and the first ends of the feed fingers, and wherein the anti-return areas of the feed fingers define a fourth distance therebetween.

10. The fastener feed apparatus of claim **9**, wherein the fourth distance is less than the first distance.

11. The fastener feed apparatus of claim **9**, wherein the feed fingers are sized and shaped so as to allow them to resiliently bias away from one another to an extent such that the fastener is permitted to pass between the anti-return areas of the feed fingers.

12. The fastener feed apparatus of claim **1**, wherein the feed portion includes a finger cover overlaying the second ends of the feed fingers.

13. The fastener feed apparatus of claim **12**, wherein the finger cover includes a bowl-shaped cavity overlaying the retention area of the feed block.

14. The fastener feed apparatus of claim **13**, wherein the cavity is sized and shaped to receive a first fastening arm of a fastening apparatus.

15. The fastener feed apparatus of claim **1**, further comprising an actuator configured to move the feed portion relative to the mounting portion.

16. The fastener feed apparatus of claim **1**, wherein the fastener includes a rivet.

17. The fastener feed apparatus of claim **1**, wherein the fastener includes a plurality of rivets stacked among one another.

18. A fastener feed apparatus, comprising:

a feed body having a first end, a second end spaced from the first end, and a track extending from the first end to

the second end, the track being sized and shaped to enable conveyance of a fastener from the first end to the second end, and

a feed block attached to the second end of the feed body and including a body and a pair of feed fingers extending from the body, each of which includes a first end formed integrally with the body and a second end opposite the first end of the feed finger, a track formed between the feed fingers, the track of the feed block including a first end adjacent the first ends of the feed fingers and a second end adjacent the second ends of the feed fingers such that the feed fingers are moveable between a relaxed position, in which the feed fingers are juxtaposed with one another, and a biased position, in which the feed fingers are resiliently biased away from one another at the second ends of the feed fingers, the track of the feed block being sized and shaped to convey the fastener from the first end of the track of the feed block to the second end of the track of the feed block, the track of the feed block being aligned with the track of the feed body, the second end of the track of the feed block including a retention areas, and the feed fingers being sized and shaped to enable retention of the fastener at the retention areas, and wherein the feed fingers, when in their biased position, provide a lateral force against the fastener to enable retention of the fastener at the retention area and prevent the fastener from traveling past the second ends of the feed fingers.

19. The fastener feed apparatus of claim **18**, wherein each of the feed fingers of the feed block includes a guiding portion located proximate to the second end thereof, and wherein the guiding portions define a first distance therebetween.

20. The fastener feed apparatus of claim **19**, wherein the retention area of the track of the feed block includes the guiding portions.

21. The fastener feed apparatus of claim **20**, wherein each of the feed fingers of the feed block includes a wall located proximate to the first end thereof, wherein the walls of the feed fingers face one another, wherein the walls of the feed fingers define a second distance therebetween, and wherein the second distance is greater than the first distance.

22. The fastener feed apparatus of claim **21**, wherein each of the feed fingers of the feed block includes a stop located proximate to the guiding portions of the feed fingers and intermediate the guiding portions and the second ends of the feed fingers, and wherein the stops define a third distance therebetween.

23. The fastener feed apparatus of claim **22**, wherein the third distance is less than the first distance.

24. The fastener feed apparatus of claim **22**, wherein the feed fingers are sized and shaped to prevent them from biasing away from one another to an extent such that the fastener is free to pass between the stops of the feed fingers when the fastener impacts the stops after traveling along the track of the feed body from the first end of the feed body to the second end of the feed body and along the track of the feed block from the first end of the feed block to the second end of the feed block.

25. The fastener feed apparatus of claim **24**, wherein the feed fingers are sized and shaped so as to enable them to resiliently bias away from one another to an extent such that the fastener is permitted to pass between the stops of the feed fingers when the feed portion is operated to move away from a workpiece along first and second axes thereof.

26. The fastener feed apparatus of claim **20**, wherein each of the feed fingers of the feed block includes an anti-return area located proximate to the guiding portions and intermediate the guiding portions and the first ends of the feed fingers, and wherein the anti-return areas of the feed fingers define a fourth distance therebetween.

27. The fastener feed apparatus of claim **26**, wherein the fourth distance is less than the first distance.

28. The fastener feed apparatus of claim **26**, wherein the feed fingers are sized and shaped so as to allow them to resiliently bias away from one another to an extent such that the fastener is permitted to pass between the anti-return areas of the feed fingers.

29. The fastener feed apparatus of claim **18**, further comprising a finger cover overlaying the second ends of the feed fingers.

30. The fastener feed apparatus of claim **29**, wherein the finger cover includes a bowl-shaped cavity overlaying the retention area of the feed block.

31. The fastener feed apparatus of claim **30**, wherein the cavity is sized and shaped to receive a first fastening arm of a fastening apparatus.

32. The fastener feed apparatus of claim **18**, further comprising an actuator configured to move the feed portion.

33. The fastener feed apparatus of claim **18**, wherein the fastener includes a rivet.

34. The fastener feed apparatus of claim **18**, wherein the fastener includes a plurality of rivets stacked among one another.

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